aa501 graphicx document

Line-of-sight Effects on Observability of Kink Modes in Coronal Structures with Imaging Telescopes

F.C. Cooper, V.M. Nakariakov, D. Tsiklauri

Valery Nakariakov,

Physics Department, University of Warwick, Coventry, CV4 7AL, England.

Kink modes of solar coronal structures, perturbing the loop in the direction along the line-of-sight (LOS), can be observed as emission intensity disturbances propagating along the loop provided the angle between the LOS and the structure is not right. The phenomenon is based upon the change of the observed thickness of the loop (along the LOS) by the wave. The observed amplitude of the emission intensity variations can be larger than the actual amplitude of the wave by a factor of two. The observed amplitude depends upon the ratio of the wave length of kink perturbations to the width of the structure and on the angle between the LOS and the axis of the structure. This phenomenon should be taken into account in the interpretation of wave phenomena observed in the corona with space-borne and ground-based imaging telescopes. Magnetohydrodynamics(MHD)– waves – Sun: activity – Sun: corona – Sun: oscillations – Sun UV radiation

Received / Accepted ???? 2002

Introduction

For last few years, a significant progress in the observational study of the MHD wave activity of the solar corona has been achieved with SOHO/EIT and TRACE EUV imaging telescopes. Flare-generated decaying oscillations of coronal loops have been observed and interpreted as kink fast magnetoacoustic modes of the loops (Aschwanden et al. 1999; Nakariakov et al. 1999; Schrijver & Brown 2000; Aschwanden et al. 2002). Fast magnetoacoustic waves have been found to be possibly responsible for such events as coronal Moreton (or EIT) waves (Thompson et al. 1998). Slow magnetoacoustic waves have been discovered in polar plumes (DeForest & Gurman 1998; Ofman, Nakariakov & DeForest 1999) and in long loops (Berghmans & Clette 1999; De Moortel, Ireland, Walsh 2000; Nakariakov et al. 2000; De Moortel 2002). This observational breakthrough gives rise to the implication of the method of MHD coronal seismology (Nakariakov et al. 1999; Robbrecht et al. 2001; Nakariakov & Ofman 2001) and supported wave-based theories of coronal heating (e.g., Tsiklauri & Nakariakov 2001), and the solar wind acceleration (e.g., Ofman, Nakariakov & Seghal 2000).

Slow and fast magnetoacoustic waves are compressive and cause perturbations of plasma density. As emission is proportional to the density, the waves can be detected as emission variations by imaging telescopes. An important characteristic of the phenomenon is the angle between the direction of the wave propagation and the line of sight (LOS). Imaging telescopes allow one to observe magnetoacoustic waves propagating with a sufficiently high angle to the LOS. In particular, this fact motivated the interpretation of the propagating EUV emission disturbances as the slow magnetoacoustic waves (see the references above). In addition, Alfvén waves, which are linearly incompressible, as well as almost incompressible kink modes of coronal magnetic structures (e.g., Roberts 2000 and references therein), can also be detected with an imaging telescope, if perturbations of the magnetic field have a component *perpendicular* to the LOS. Indeed, as the magnetic field is frozen-in in the coronal plasma, the perpendicular displacement of the field can be highlighted by variation of emission intensity.

In this letter we discuss alternative way of the observational detection of kink modes of coronal magnetic structures, oscillating in the plane *containing* the LOS. It is shown that this would lead to modulation of the intensity of the emission *along the axis of the structure*, produced by the change of the observed thickness of the loop.

Kink modes of cylindric magnetic structures

Kink modes of coronal loops, observed, in particular, with TRACE EUV imaging telescope (see the references above), are periodic transverse displacements of the magnetic flux tube forming the loop. They should be distinguished from sausage modes which do not perturb the tube axis. Modeling the loop tube as a straight magnetic cylinder uniform along the axis, Edwin & Roberts (1983) found that the kink modes can be either surface or body, depending upon the structure of the mode inside the tube. Also, the modes can be slow or fast, corresponding to fast and slow magnetoacoustic waves modified by the structuring of the medium. In particular, in the low-β plasma of the solar corona, coronal loops can support fast and slow kink body modes.

In the case of a kink mode, the loop tube oscillates almost as whole, and the cross-section of the loop is practically not perturbed by the oscillation. Also, the density perturbation inside the loop is insignificant in this mode. Indeed, for fast magnetoacoustic waves in a low-β coronal plasma, the field-aligned flows V_z are much smaller than the transverse motions V_x. Consequently, from the continuity equation, one gets that the density perturbations $\tilde{\rho}$ are connected with the transverse perturbations by the expression equation $\tilde{\rho}\rho_0 \approx \sqrt{1 - C_{A0}^2 k^2/\omega^2}\ V_x C_{A0}, dens$